Read only

SCIENTIFIC AND TECHNICAL INFORMATION SYSTEM

1. Acc. Number	1A. Act. Code	2. Trans Type	3. Effort Status	4. Perf. Meth.
DS000787	**AQPO**	**M Modify A Record**	**C Completed**	**C Contract**

Performance Type 5.	6. Date of Summary	7. Prec. Sum Date	8. Start Date	9. End Date	Continuous End
R RDT&E Work Unit	**2003/02/24**	**2002/03/08**	**2000/03/03**	**2001/01/01**	

10. Sec. Class.	18. Distribution Code	19. Distribution Reason
U Unclassified	**A Distribution Unlimited**	**PB Public Release**

20. Title
STP 1021, Machine Vision Seal Area Inspection, Poly Trays

22. Linking Accession Number (Select Up to Two)		23. Local Control Number	24. Search Data
DS	**441**	**STP 1021**	**2003**
DS	**789**		

25. Subject Categories

Code	Description
1308	**Manufacturing and Industrial Engineering and Control of Production Systems**

26.1 Mission Area

Code	Description
5.1	**Logistics**

26.2 Function Code

Code	Description
7.2	**Manufacturing Technology**

26.3 Technology Code

Code	Description
4.2.2	**4.2.2 Manufacturing Cell Control Technology**

27. Resp. Org. Source	27.1 Responsible Organization Name
432549	**DEFENSE LOGISTICS AGENCY FORT BELVOIR VA**

27.2 Responsible Organization Component Name
J-339, R

27.4 Responsible Individual

Last Name	First Name	MI
EGGERS	**RUSSELL**	**K**

20040521 035

27.5 Resp. Indiv. Off. Sys.	27.6 Resp. Indiv. Phone	27.7 Resp. Indiv. DSN No.
J-339	**703-767-1417**	**427-1417**

28. Perf. Org. Source
410970

28.1 Performing Organization Name
RUTGERS - THE STATE UNIV PISCATAWAY NJ

28.2 Performing Organization Component Name
Center for Advance Food Technology (CAFT)

28.4 Performing Individual

Last Name	First Name	MI
COBURN	**JOHN**	

28.5 Perf. Indiv. Off. Sys.	28.6 Perf. Indiv. Phone	28.7 Perf. Indiv. DSN No.
DIR, FMTF	**732-445-6132**	

28.8 Associate Investigator Names (Last, First, MI)
CAnavan **JEFFREY**

35. Keyword Text

SEAL AREA
BLISTERS
DEFECTS
CONTAMINATION
SURFACE
RATIONS
THERMOSTABILIZED
FLEXIBILITY
DUAL USE
ROBOTICS
INTEGRATION
SHOP FLOOR
PARTNERS
FOOD PRODUCT EDGE
WRINKLES
KNURLED

36.1 Objective
TO INSTALL AN EXISTING SINGLE-CAMERA MACHINE VISION SYSTEM ON THE RACQUE FILLING MACHINE IN THE DEMO SITE TO DETERMINE THE RELATIONSHIPS BETWEEN SEAL AREA CONTAMINATION AND SEAL DEFECTS. THE SYSTEM WAS PREVIOUSLY DEVELOPED TO A PROTOTYPE STAGE ON THE TIROMAT HORIZONTAL FORM, FILL, AND SEAL MACHINE, WHERE IT DEMONSTRATED FEASIBILITY ON MRE POUCHES.

37.1 Approach
USE EXISTING EQUIPMENT AND THE INFORMATION GAINED FROM PREVIOUS EXPERIENCES TO EXAMINE THE FEASIBILITY OF USING MACHINE VISION SEAL AREA INSPECTION SYSTEMS IN THE PROCESS OF FILLING AND SEALING POLYMERIC TRAYS. THIS IS A COST SAVINGS AND EXPANDS ON ALREADY MATURE TECHNOLOGY.

38.1 Progress
WHEN ALLEN-BRADLEY, THE ELECTRONIC COMPONENT MAKER FOR THE PROTOTYPE MACHINE, STOPPED MAKING THOSE COMPONENTS. ANOTHER SOURCE WAS FOUND AND WE PROCEEDED WITH THE PROJECT PLAN. AFTER SIX MONTHS OF DELAY, THE PROJECT IS COMPLETED AND INSTALLED ON THE RACQUE FILLING LINE FOR POLY TRAYS, AND IN USE IN PRODUCTION.

30. Primary PE No.	31. 1st Contrib. PE No.	32. 2nd Contrib PE No.
0708011S		
30A. Primary Proj. No.	31A. 1st Contrib. Proj. No.	32A. 2nd Contrib. Proj. No.
2003		
30B. Primary Task No.	31B. 1st Contrib. Task No.	32B. 2nd Contrib. Task No.
STP1021		

30. Primary Funding Data			31. 1st Cont. Funding Data			32. 2nd Cont. Funding Data			33. Contract Rollup Indicator
Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	Fiscal Year	Dollars	Work Year	
C1	C2	C3	C1	C2	C3	C1	C2	C3	C
2000	**7295**	**2000**							
D1	D2	D3	D1	D2	D3	D1	D2	D3	D
E1	E2	E3	E1	E2	E3	E1	E2	E3	E
F1	F2	F3	F1	F2	F3	F1	F2	F3	F
G1	G2	G3	G1	G2	G3	G1	G2	G3	G

39A. Product Set No.	39.1A Prod. Title Class Code	39.2A Product Title	
	Unclassified		
39.3A Product ID/Report No		39.4A Product AD No	39.5A Product Indicator

39B. Product Set No.	39.1B Prod. Title Class Code	39.2B Product Title	
	Unclassified		
39.3B Product ID/Report No		39.4B Product AD No	39.5B Product Indicator

39C. Product Set No.	39.1C Prod. Title Class Code	39.2C Product Title	
	Unclassified		
39.3C Product ID/Report No		39.4C Product AD No	39.5C Product Indicator

39D. Product Set No.	39.1D Prod. Title Class Code	39.2D Product Title	
	Unclassified		
39.3D Product ID/Report No		39.4D Product AD No	39.5D Product Indicator

39E. Product Set No.	39.1E Prod. Title Class Code	39.2E Product Title	
	Unclassified		
39.3E Product ID/Report No		39.4E Product AD No	39.5E Product Indicator

34. Contract/Grant/Trans. No.	34.1 Contract Effective Date	
34.2 Contract Expiration Date	**34.3 Contract Face Value**	**34.4 Contract Cum. to Date**
SPO103-96-D-0016	2002/03/08	
2001/01/01	$72,950.00	$72,950.00

40. Dom. Tech Trans.	**HI High potential for civilian application**
41. Study Category	**5 Science, Technology, Systems and Equipment**
42. Spec. Study Sub	**CE Cost benefit or economic analysis**
44. Prim. Proj. Serial No	
45. Int. Sources Con.	**Y**
46. Processing Date	**2002/03/24**
47. Receipt Date	

49. Thrust Indicator

Technology for Affordability

Focal Point
Russell Eggers

Author
Russell Eggers

Status Code **Submittable to DTIC**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*: 02-04-2002

2. REPORT TYPE: FINAL

3. DATES COVERED *(From - To)*: Mar 2000 - Jul 2001

4. TITLE AND SUBTITLE
Machine Vision Inspection of Polymeric Traypack Seal Areas

5a. CONTRACT NUMBER: SP0103-96-D-0016

5b. GRANT NUMBER: PR - 88003

5c. PROGRAM ELEMENT NUMBER: PE - 7811s

5d. PROJECT NUMBER: CORANET STP #1021

5e. TASK NUMBER

5f. WORK UNIT NUMBER

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8. PERFORMING ORGANIZATION REPORT NUMBER: FTR-113

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
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Fort Belvoir, VA 22060-6221

10. SPONSOR/MONITOR'S ACRONYM(S): DLA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This report documents experimental results of a modified production Machine Vision Inspection system for the polymeric traypack. The traypack is a replacement for the group feeding metal traycan. Polymeric traypacks are heat sealed with a foil laminate film lid. Seal area contamination during filling and handling before sealing can be expected in polymeric traypacks. Since entrapped matter can lead to open seals, defects, and seal anomalies, a method of measurement for seal area contamination is useful in quantifying effects of filler changes, line speeds, and product formulations. Proper lighting was the most important factor in achieving accurate results. The unit was 96% effective at detecting small areas of opaque contamination after lighting changes were made. Experimental contaminates used were creamed ground beef, beef stew and water. Offset, diffuse lighting yielded significantly improved results for the products tested compared to the integrated, direct strobe light. Additional fine-tuning will be required to obtain 90+% effectiveness with water.

15. SUBJECT TERMS
group feeding, polymeric traypack, seal inspection, production unit, advanced technology, defects, contaminates, quality control, machine vision, single camera, rigid tray

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	30	

COMBAT RATION NETWORK

FOR

TECHNOLOGY IMPLEMENTATION

Machine Vision Inspection of

Polymeric Traypack Seal Areas

Final Technical Report STP 1021

Results and Accomplishments (March 2000 - July 2001)

Report No: FTR 113

CDRL Sequence: A004

March 2002

CORANET CONTRACT NO. SPO103-96-D-0016

Sponsored by:
DEFENSE LOGISTICS AGENCY
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Contractor:
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Jeffrey S. Canavan
Neal Litman

Table of Contents

1.0 Introduction

STP #1021 began on March 3, 2000 based on a Technical Proposal dated September 10, 1999. The objective of this project was to demonstrate a single camera, prototype machine vision seal area inspection system installed on a production polymeric traypack line located at the CORANET DEMO site. The Machine Vision Seal Area Inspection prototype for MRE pouches, demonstrated in CRAMTD, was updated and applied to inspection of traypack seal areas prior to sealing.

2.0 Background

A preventative element within the heat sealing process is needed to avoid defects before they occur. It is highly desirable to determine the suitability of the seal area before sealing the traypack. At high line speeds, such an approach must rely on automated, machine vision technology in order to reliably process containers at 15 per minute. A seal is acceptable if there were no product or other contaminant found on any of the four borders of the seal and the sealing process was under control. The seal pressure, temperature and dwell time are controlled components of the sealing process and both controlling and monitoring of these variables can be done automatically. Using machine vision for seal area inspection has already been established.

During the completed Phase I of the MRE Pouch STP, a cost/benefit study for operating a machine vision inspection system was conducted and reported in Technical Working Paper (TWP) #207. The results of that economic analysis show a very favorable return on investment and substantially strengthen the attractiveness for implementing this on-line inspection system. The Polymeric tray replacement for the metal tray-can is an urgent program of great importance to the Military Services, especially since past metal cans are showing evidence of premature deterioration.

Since the lidstock of a polymeric traypack is the same material as is used for MRE pouches and its seal is a thermal weld (as contrasted to past metal can seams), seal defects which occur in MRE production can be expected in the Polymeric Traypack.

Short Term Projects have been proposed to address the performance of high-speed fillers. The Machine Vision system can be used to quantify performance improvements as well as defining the level of contamination, if any, that can be accommodated in the process.

3.0 Results And Recommendations

Experiment data shows the prototype system is capable of detecting 90%-96% of opaque contamination in the tray flange area. As a measurement tool, it is very capable of quantifying the effect of filling rates and filler design on seal contamination. Lighting was the primary factor at controlling system effectiveness.

Because lighting was identified as the primary factor controlling the effectiveness of the vision system, several prototype lightning systems were put together to better understand this relationship and to determine what the potential capability of the camera system can be with an optimal lighting system. Machine Vision data was collected with contamination caused by Creamed Ground Beef and Beef Stew with these different lighting systems. The vision system effectiveness was 96% effective at detecting small areas of splashed, opaque contaminates (0% false positives) with the best lighting system. The vision system was less effective with the integral lighting system from the camera. Glare from this current lightning system caused decreased the performance of the system to 0%-34% with small area contamination.

Machine Vision data collected on clear liquid contamination, as might be found in Pork Sausage in Brine, indicated a deficiency in the current lighting system. In the optimal lighting areas with the current lighting system, only 50% of the smallest water splatter could be detected. To detect clear contaminates most effectively, the lighting system would need to be modified to incorporate off-axis, diffuse lighting. The current on-axis, high intensity lighting system was carried over from the original vision system. Modifying the lighting system to incorporate diffuse, off-axis lighting would improve performance for all products, since glare could be eliminated. Experimentation with varying light sources and angles showed consistent results could be obtained in all tray areas with lighting changes. See Appendix 5.1, Experiment Data and Analysis.

As an analytical instrument, the prototype machine is a valuable tool for quantifying seal area contamination before sealing. It is a valuable asset in projects that require accurate contaminate measurement. It is recommended that projects needing such functionality should use machine vision.

As an inline inspection system, the prototype design could be utilized as the model for future production units. Reliable, automated inspection of trays is possible with the system, given a more optimized lightning system as previously discussed. The vision system would identify trays that have contaminates in the seal area and divert the tray for manual cleaning of the seal area. The tray would then be put back on line to be sealed. This vision system would therefore prevent contaminated trays from being sealed and reduce waste. The estimated cost to produce additional systems that are functionally equivalent to the retrofitted unit was quoted from Xyntek to be $45,000-$50,000.

Next Steps

Changing the current lighting system to a diffuse, off-axis arrangement could be incorporated to increase detection accuracy in all tray areas. Alternative machine vision detection ranges, such as temperature detection in IR or near-infrared ranges, could be explored with a change in cameras. Identification by heat signatures on tray flanges could be more reliable than any optical system since most, if not all, lighting and glare issues are eliminated. However, heat-sensing systems require a temperature difference between trays and contaminants.

4.0 Short Term Project Activities

4.1 Phase I Tasks

4.1.1 Phase I, Task 1 Problem Specification

See Appendix 5.2.1, Specifications, Diagram and Images.

4.1.2 Phase I, Task 2 Review Capabilities of Existing Model

Tests of the existing Configurable Vision Input Module, (CVIM) system proved that it lacked the processing power and resolution to meet defined detection criteria when acquiring a moving target. The CVIM system was limited to a detection limit of 0.25 inch. Even at this limit, each tray would have to be stopped before being scanned. Since the traypack line is has no provision for indexing trays to stop motion, the CVIM was not capable of providing enough resolution for complete seal inspection. However, the enclosure and lighting system were determined to be adequate for the capturing the required field of view with other 'off-the-shelf' vision components with faster frame capture rates.

4.2 Phase II Tasks

4.2.1 Phase II, Task 1 Develop the Prototype for Adaptation into the Raque System

When this project was originally proposed, the CVIM color system was to be moved from the Tiromat HFFS line to be integrated into the Raque Tray Sealer line. The task became more complicated when no integrator could be identified to re-program the Allen-Bradley system for the project economically. A more flexible system with a newer processor and camera from Cognex was selected to replace the obsolete system. Cognex was the hardware manufacturer that produced the vision system components on the Pouch Vision System developed in CORANET STP#1007.

Comprehensive testing in the integrator's development laboratory (Xyntek) proved that the selected components could meet the design specifications outlined in Phase I for both fixed and moving targets for the field of view required for complete seal flange inspection. Adjustment of the camera assembly within the enclosure was adequate to capture the inspection areas without optical anomalies.

4.2.2 Phase II, Task 2 Installation on Line

Once the camera was installed into the enclosure, it was found that the enclosure limited field of view such that it was insufficient to capture the entire tray flange. Minor engineering modifications were made to correct this problem. The mount was raised and some plastic shims were inserted to extend camera range over the conveyor.

Steam from hot products initially fogged up the optical assembly and caused only a white screen to be captured. A fan was added to the camera housing and the access door was left open to allow for airflow around the camera.
Originally, the system was going to monitor product flow and automatically sense when a tray was in the correct position before inspecting the seal area. However, it was found that a proximity sensor was necessary to provide adequate repeatability. A through beam sensor was installed on the conveyor to trigger the camera when a tray was in the correct position. Some fine-tuning of the trigger timing was required to decrease positional variation enough to capture images at production conveyor speeds. Data logging was preformed by a stand-alone pc via serial connection. Individual tray area contamination information could be analyzed and compared to seal reject outcomes.

4.2.3 Phase II, Task 3 Performance Test

The unit was tested prior to acceptance at Xyntek's development lab and met defined performance specifications for the sample test of 20 trays. Contamination size and location was identified to 0.1 inch at 30 tray/minute. Additionally, experiments were carried out at the FMT Facility to quantify the functionality of the system under production conditions.

4.2.3.1 Macaroni and Cheese

Machine Vision data was collected during weekly runs of Macaroni & Cheese. The majority of the system fine-tuning was carried out during these runs. Analysis and correlation of contamination and reject data proved inconclusive, however. Sealing characteristics vary significantly between the thin nylon film used for peelable seals and the quad laminate foil film used for retortable trays. Higher sealing temperatures and sealing time tend to reduce the seal weakening effect of contaminates. However, excessive heat or seal time can weaken the film. The thinner peelable film requires much less heat and time to seal effectively. While the system identified about 20-30 trays per 100 tray run to be contaminated, less than 1% of Macaroni and Cheese trays was rejected based on inadequate seal due to seal contamination.

4.2.3.2 Creamed Ground Beef

Experiments were conducted to quantify the effectiveness of the vision system with black trays. Test samples were created systematically with three levels of contamination. Detection parameters were validated with clean trays.

The system was 0%-34% effective at detecting light spray contamination, with an average over all areas of 21%. Smearing of light contamination reduced system detection effectiveness. System detection for smeared ground beef was 3%-28%, with an average of 15%. More contamination increased the detection performance significantly for all areas, including areas with lighting glare. The heaviest contamination was detected with an effectiveness of 63-78%, with an average over all the areas of 71%. See Appendix 5.1 for charts and data. During the experiments, the system display would indicate glare on the test captures, reducing the effectiveness of the system.. Changes in the lighting system proved later on to be effective in increasing the system effectiveness for this material (see section 4.2.3.5 and 4.2.3.6).

4.2.3.3 Beef Stew

The system was 34%-81% effective at detecting light spray contamination, with an average over all areas of 48%. Smearing of light contamination had only marginal effects. System detection for smeared beef stew was 22%-81%, with an average of 50%. More contamination increased the detection performance. The heaviest contamination was detected with an effectiveness of 81%-98%, with an average over all the areas of 91%. See Appendix 5.1 for charts and data. Again in this case, changes in the lighting system should be considered to improve the effectiveness for small contaminates.

4.2.3.4 Water

The system with the current lighting system was 0%-50% effective at detecting light spray contamination, with an average over all areas of 12%. Smearing of light contamination caused an increase in system detection effectiveness in most areas. System detection for smeared water was 0%-79%, with an average of 22%. More contamination increased the detection performance in areas without glare. The heaviest contamination was detected with an effectiveness of 0%-72%, with an average over all the areas of 30%. Glare severely hindered system performance. Reduction in glare should make every detection area as effective as the most effective area. See Appendix 5.1 for charts and data.

4.2.3.5 Creamed Ground Beef II – Integral Lighting

Experiments were conducted to quantify the effectiveness of the vision system with the current **"blue"** trays. Test samples were created systematically with two levels of contamination different from previous experiments. Detection parameters were validated with clean trays.

The system with the current lighting system was 0%-82% effective at detecting ~4mm diameter contamination, with an average over all areas of 19%. Larger size contamination increased the detection performance significantly for all areas, including areas with lighting glare. 8-9mm wide contamination was detected with an effectiveness of 82%-100%, with an average over all the areas of 96%. See Appendix 5.1 for experiment notes.

Again, glare turned out to be a system limitation that drastically reduces system performance with creamed ground beef contaminates. Additionally, the program defines the entire flange location by a pair of coordinates. Glare and shadows were sometimes cause for inconsistencies in object placement accuracy, leading to incorrect identification of the flange areas. In addition to improved lighting, additional frame references within the program algorithm are recommended to identify regions based on more local data points. The additional fixture locations for different zones would be more accurate since the relative distance between the detection zones and the frame references would be smaller.

4.2.3.6 Creamed Ground Beef II & Water – Experimental Lighting

Changes were made to the lighting system to provide a more diffuse, indirect arrangement. With the experimental lighting, the system effectiveness increased from

0%-82% to 90%-100% effective at detecting ~4mm diameter creamed ground beef contamination.
Experiments with water showed some improvement from the old system. However, more fine-tuning of the system would be required for 90+% effectiveness.
See Appendix 5.1 for experiment notes.

Glare reduction definitely increased the system effectiveness. Higher light levels allow the lens aperture to be closed. Smaller aperture settings bring more of the image into focus and enhance system edge detection. However, brighter light requires careful attention to shadows because the system will define shadow gradients as defects and might cause problems in flange area location detection.

4.3 Phase III Tasks

4.3.1 Phase III, Task 1 Engineering Design of Production System

This task was completed in Phase II, Task 1. New hardware and software was incorporated into the prototype unit. With the changes, the system could inspect trays at production rates. Ration producers who are interested in the engineering specifications for a production unit are referred to Appendix 5.2.1.

5.0 Appendix

5.1 Experiment Data and Analysis

Machine Vision on the Polytray Line Experiments (May 2001)

Overview: The tests included four groups. The control group consisted of empty trays. Each of the three contaminated sample groups had 3 sub-groups outlined below.

Holes were cut into bottoms of trays for vacuum equalization during sealing. Trays were marked and numbered so orientation was consistent and the vision data could be correlated. Contamination was placed in all inspection regions, each of 4 sides and 4 corners. Trays were fed through vision system, analyzed, recorded, and then sealed under vacuum. Following sealing, the trays were inspected for defects and the results recorded.

Lighting System: Original, Integral Lighting System

Test Groups:

Group 1; 96 Trays, empty. For baseline detection noise and sealing validation.

Contamination Characters

Group 2; 96 Trays, clear, room temperature, tap water

32 light spray, splatter, encompassing 1" of inspection area
(All 'light spray' was created in the following way for all contaminates; Results obtained by inserting a finger to the first knuckle into the contaminate, then flicking the contaminate onto the seal area.)

32 mild smear, continuous smear 1" long, less than seal width
(The same technique was use as above, except the material was then smeared.

32 large drop, completely across seal area
(A drop approximately 4mm in diameter was place in each seal area)

Group 3; 96 Trays, Creamed ground beef

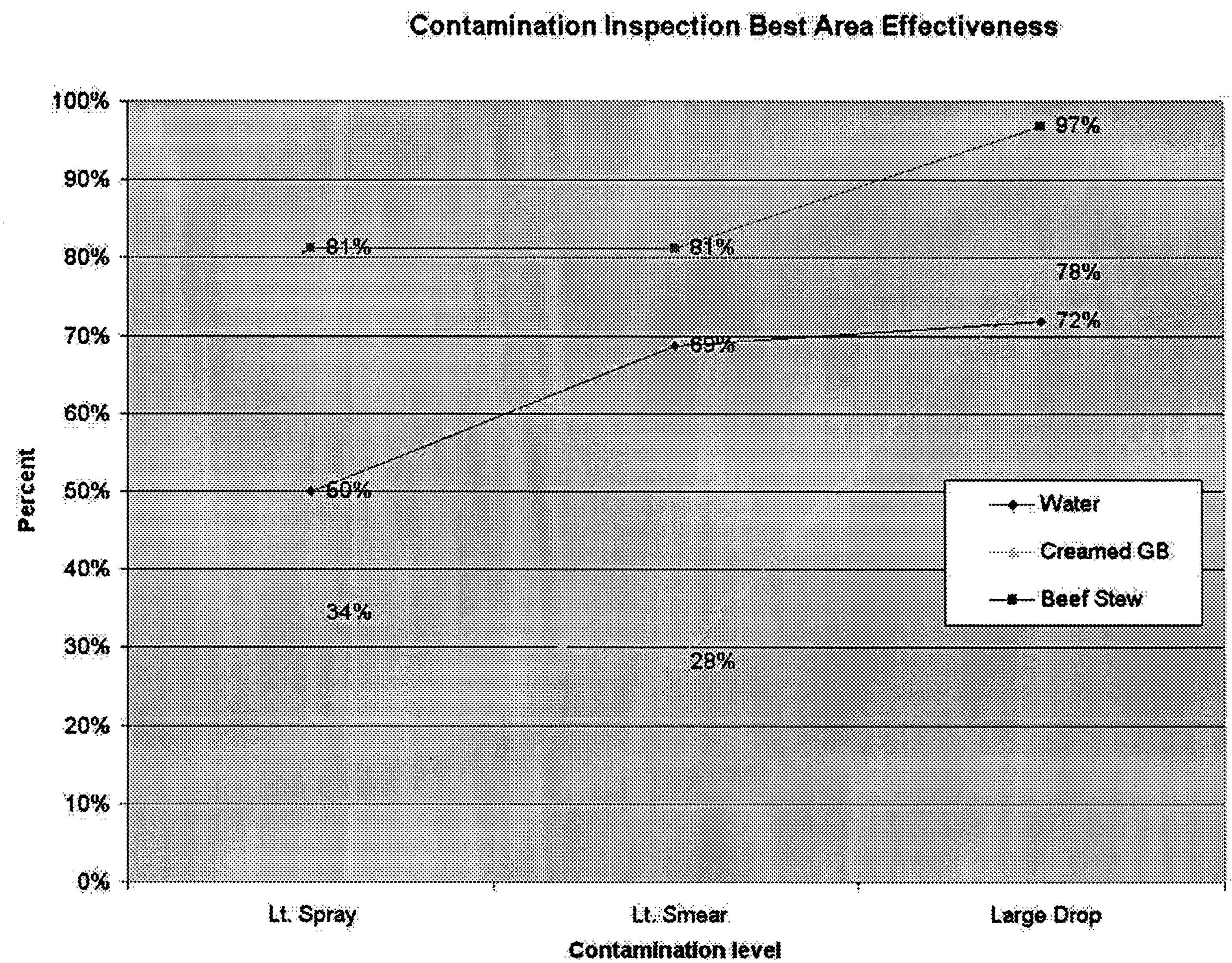
32 light spray, 32 mild smear, 32 large drop

Group 4; 96 Trays, Beef stew

32 light spray, 32 mild smear, 32 large drop

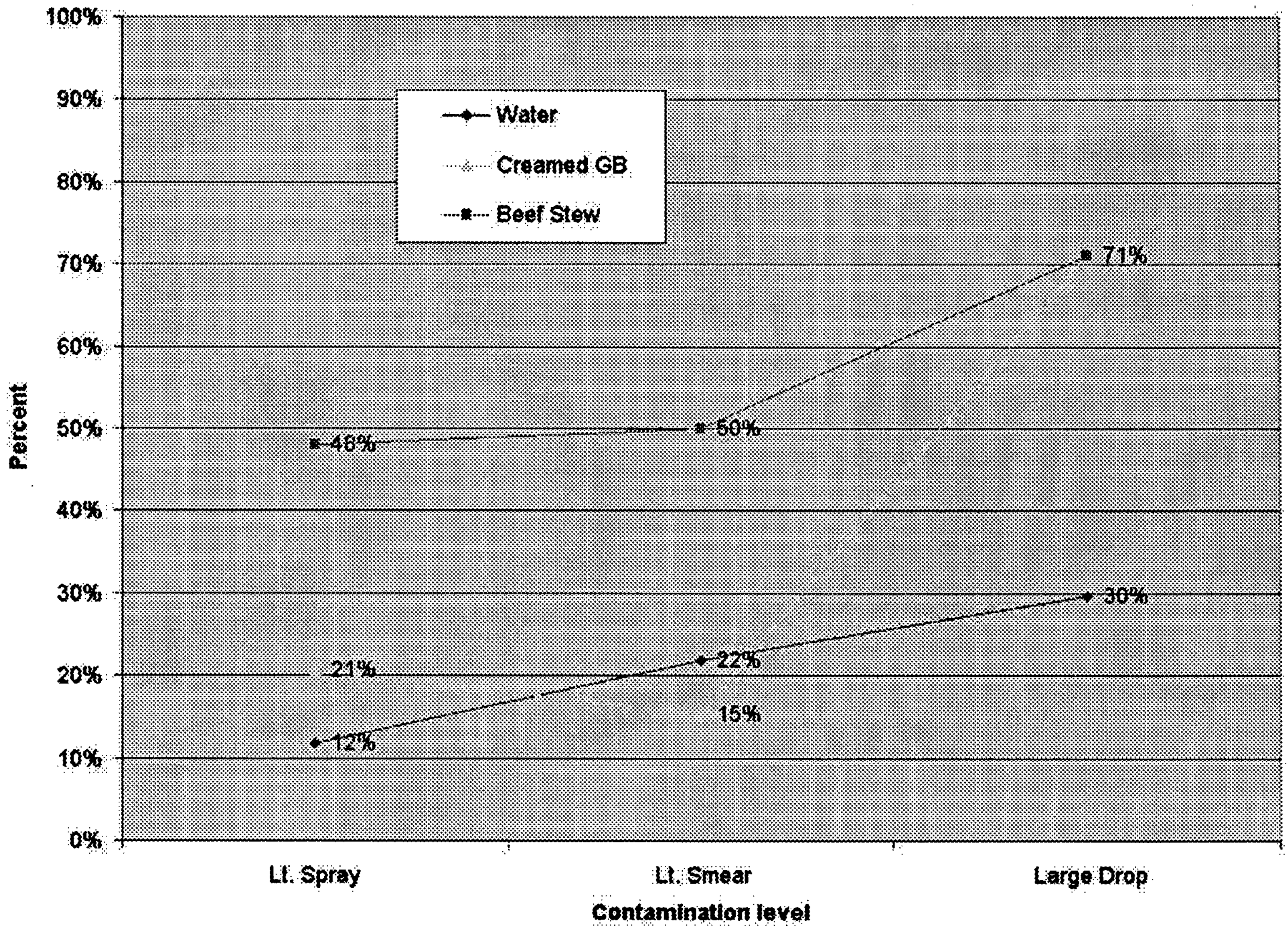
The charts that follow summarize the test results. Large droplet contamination detection in the tray areas without glare ranged from 72%-97%. Light spray contamination and smears ranged from 34%-81% and 28%-81%, respectively. Correlation between seal contamination and seal defects could not be adequately defined from the data. Not all seal contaminates lead to visual seal defects. Lack of this correlation could be attributed to sealing factors. Contaminates can be pushed out of the seal area by the seal bar and an adequate fusion seal can be formed under the proper seal pressure, seal time and seal temperature conditions.

It should be noted that some trays with minimal seal contamination had better seals than trays that had clean seals but were systematically wiped. This observation was made in one of the production runs which lead to the conclusion/recommendation that trays that have no seal contamination should never be wiped as it can cause contamination. This emphasizes the potential importance of a vision system that detects contaminates and rejects them for cleaning rather than have an inspector/seal wiper clean trays arbitrarily.



Contamination Inspection Best Area Effectiveness
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent
81%
81%
97%
78%
72%
69%
50%
34%
28%
Water
Creamed GB
Beef Stew
Lt. Spray
Lt. Smear
Large Drop
Contamination level

Contamination Inspection Average Effectiveness



Blue Tray Machine Vision Test Notes - 2/28/02

To: File
From: Rieks Bruins

On 2/28/02, additional tests were conducted with the Vision System using the new "blue" trays from Rexam. As contaminate the sauce of a Creamed Ground Beef Product was used.

Three experiments were conducted after the system was setup and adjusted for maximum performance. Each experiment consisted out of 1 tray run 10 times through the system at a line speed of 15 trays/minute. The lighting system was setup with:

- B2W=9.00 W2B=11.0

Test Description:

A) The first set of trays were trays without any contaminates. This test identifies the performance characteristic of the Vision System as False Positive, e.g. trays that are erroneous identified with contamination

B) The second set of trays had large contaminates in each of the eight distinct areas of the seal. The size of the contaminate was about 8-9 mm wide. This test identifies the False Negative performance of the system for a specific category contaminate

C) The third set of trays had small contaminates ~ 4 mm in size in each of the eight distinct areas of the seal. This test identifies the False Negative performance of the system for a specific category contaminate

Results:

Test A: 100% of the trays were correctly identified to not having contaminations.

Test B: 95.4% of the contaminates were correctly identified. The false Negatives or contaminates that were not identified were 5.6% . It should be noted that the false negatives were all located in the corner areas of the seal.

Test C Only 19.3% of the small contamination were correctly identified. The false negative for this category contamination was therefore 80.7%. A more in depth analysis reveals however that ten performance index is a strong function to the area in which the contaminate is located. For example one seal area had only a 18.2% false negatives.

Conclusion:
The system has currently several limitations that effect the performance:

1) The lighting of the flange area causes glare which could cause false positive. In order to avoid this the lighting system needs to be adjusted which then lowers the performance of the system in regards to false negatives. A solution for this deficiency is (indirect, diffuse lighting).
2) The vision system relies on a consistent geometry of the flange and can not adjust itself to variation in flange geometry causing it sometimes to misread the where the flange is located. To fix this problem a multiple camera system is recommended each camera system identifying where the flange is located that it needs to observe, (more reference points for fixture placement).

Next Steps: Try different (lights and) lighting angles to see if the glare can be eliminated

Lighting Experiment Notes

To: File
From Rieks Bruins
Date: 3/5/02
Re: Vision System Polymeric Tray

Previous experiments (2/28/02) indicated good performance of the vision system in detecting large seal contamination defects caused by creamed ground beef (95.4% effective) but poor performance of the system on small defects (19.3% effective). Additional experiments were therefore executed on 3/5/02 with different lightning systems.

Two 500 Watt Halogen lights were purchased to and located about 3 ft on either side from the center of the container and about 1 ft above the container. To avoid direct lightning of the flanges and creating reflections of the light source into the camera, a translucent film was placed in between the light sources and the container. In addition the lightning of room A was turned off to avoid any reflection of this lighting system. This lightning setup increased the performance of the vision system to detect small (4mm contaminates) to 90-100%. This experiment proved that lighting is one of the primary factors to controlling the efficiency of the vision system.

Next, experiments were executed with water contaminates. The performance of these type contaminates were significant lower indicating that additional adjustments of the lighting system need to be made in order to detect these contaminates with an reliability of 90%+.

Conclusions:

- Higher intensity light needs to be used for detecting contaminates
- To avoid reflections, which will cause false positive contaminates, the tray should be lighted indirectly, much like systems used in photography
- Higher intensity lightning will allow smaller lens opening and sharper images, thus increasing clearer detection of contaminates
- Water contaminates are the hardest to detect and require some additional experiments with different lightning systems

5.2 Prototype MV System

5.2.1 Specifications, Diagrams and Images

September 29, 2000

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120 New England Ave.
Piscataway, NJ 08854

STP #1021 - Vision System Seal Area Inspection on Traypack Line
Principal Investigator: Jeff Canavan

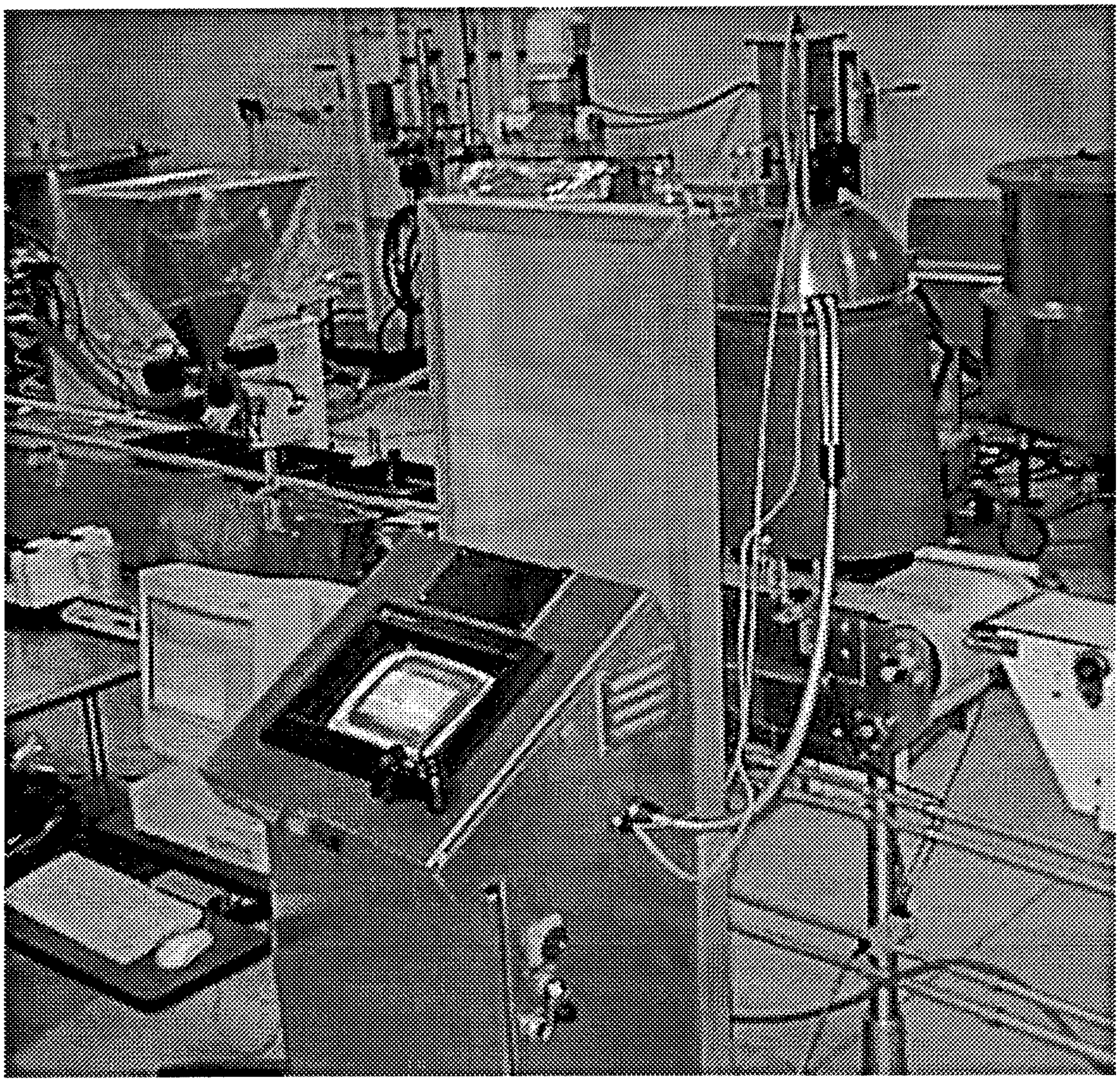
Estimated Subcontractor Scope

1. Engineering Site Visit - collect relevant environmental and equipment information
2. A-B Color CVIM system will be transported to contractor's facility
3. Imaging Requirements - using trays supplied by Rutgers, determine effective configuration; lighting, FOV, lens, camera position, mounting of camera/lighting, etc.
4. Integration - determine trigger and data transfer requirements
5. Fabricate modifications
6. Programming for CVIM (PLC or PC if necessary)
7. Transport CVIM to Rutgers
8. Install CVIM system with all modifications onto Traypack line
9. Test and Debug system

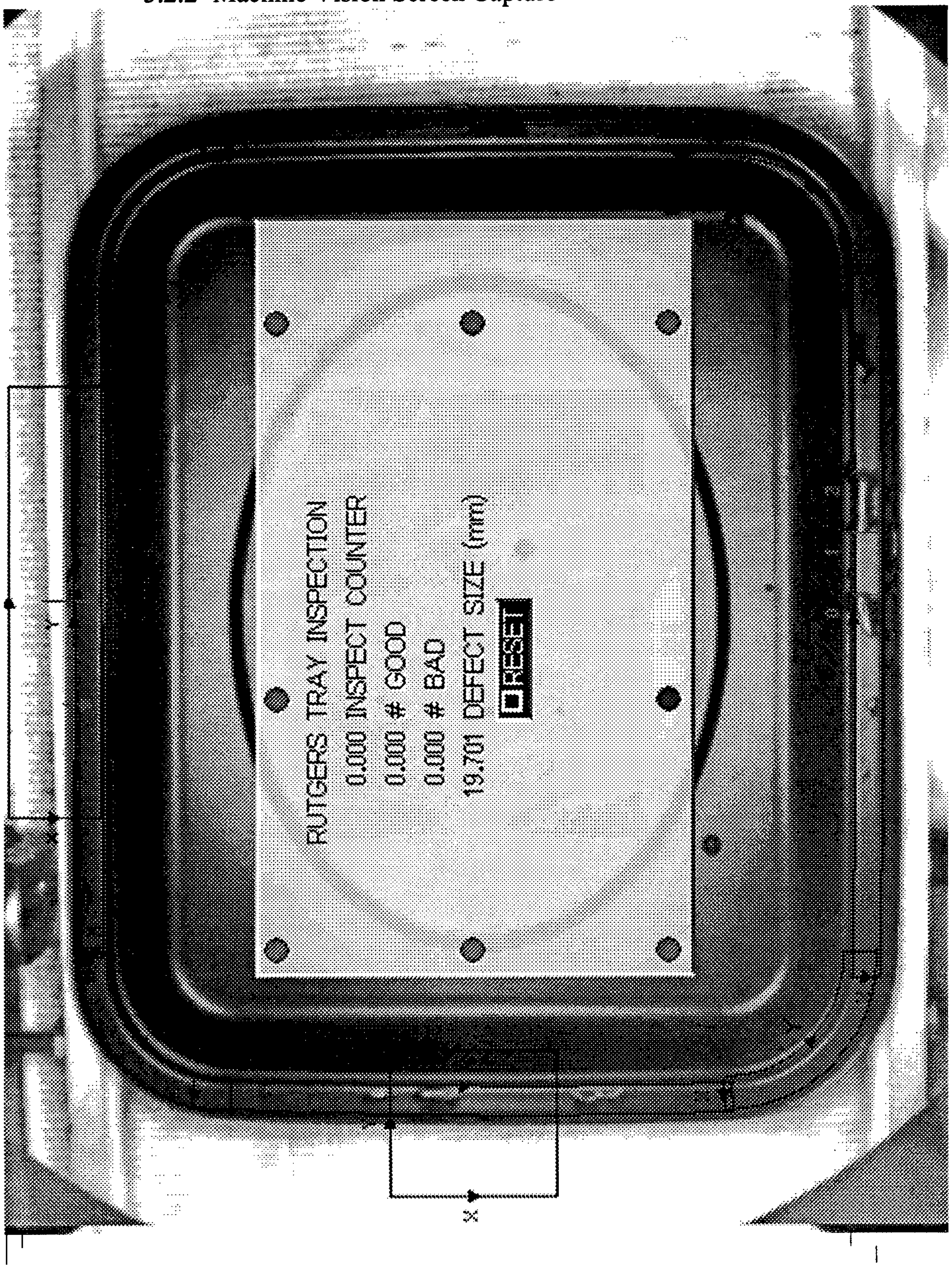
System Functional Requirements

Vision system will measure seal contamination to 0.1" dia droplets
Contamination will be registered by: size and position or segment and area
Data will be transferred to a PC
Production lines speed: 30 trays/min. max., tray spacing: 14.25"
Provision for future reject mechanism at discharge

Machine Vision System in place at the FMT Facility



5.2.2 Machine Vision Screen Capture



5.3 Vendor Proposal

XYNTEK INC.

• Machine Vision Engineering • Process Control Engineering

Memorandum

Memo

Date: 4/2/02

From: Dan Freed
To: Mr. Jeff Canavan

Subject: Quotation 2652-F/ Dated 9/29/2000

Jeff,
This is a notification that the subject document may be released as part of your reporting requirements related to this project.

Sincerely,
Dan A. Freed – Automation Systems Sales Manager

301 Oxford Valley Road
Bldg 1402-A
Yardley, PA 19067

(215) 493-7091 Voice
(215) 493-7094 Fax

RUTGERS UNIVERSITY

Center for Advanced Food Technology

MACHINE VISION, PLC, and MOTION CONTROL

ENGINEERING DESIGN & DEVELOPMENT, IMPLEMENTATION, and SUPPORT SERVICES

Quotation : #2652-F

Date: September 29, 2000

Prepared For :	Mr. Jeff Canavan
	Rutgers University
Tel :	732-445-6140
Fax :	732-445-6145

Prepared By :	Dan Freed
	Xyntek, Inc.
Tel :	215-493-7091 (x222)
Fax :	215-493-7094

RUTGERS UNIVERSITY
Center for Advanced Food Technology

MACHINE VISION, PLC, and MOTION CONTROL
ENGINEERING DESIGN & DEVELOPMENT,
IMPLEMENTATION, and SUPPORT SERVICES

Xyntek's team of Professional Engineers would be pleased to offer their **MES, MRPII, SCADA, Real Time Continuous or Batch Process Control, Machine Vision, PLC, Motion Control, Design and Implementation Services** to complete the tasks as described below.

Project Description

Rutgers University – Center for Advanced Food Technology has asked Xyntek to modify an existing machine vision inspection station for use in a new application to inspect a different tray format. Xyntek will make use of the existing Rutgers' machine vision unit to the extent practical to meet the defined inspection requirement. Xyntek will implement the necessary lighting and optics design together with the machine vision application programming as described in this proposal.

The inspection requirement calls for the inspection of the seal area on black plastic trays per the samples that have been provided to Xyntek:

- 12.75" x 10.5" size tray
- The trays move continuously on a white belt conveyor. There are conveyor guides.

The following is a summary of our technical assessment and the design strategy for moving forward with the project.

Calculations

1. **Image Resolution**
   Assume 15” wide FOV
   1 pixel = 15”/640 = 0.0234375”
   smallest detectable spot under ideal conditions = 1 blob = 4 pixels square = (2(0.0234375”))^2 = 0.0022 sq in.
   1 blob is .0022sq in. in area which is approximately .05” x .05” in size

2. **Motion**
   The system can tolerate up to 20 in/sec of linear motion. The conveyor must move slower than 20 in/sec to capture a clear image of the tray.
   20 in/sec = 100 feet/min

Lab Results

Seal Inspection Regions
A 0.25” wide portion of the seal around the entire perimeter of the tray is inspected for dark and light contaminants as defined below. The *four corners of the seal* are included in the inspection. The inspection regions have X,Y, and Rotational fixturing to accurately position the regions on the seal area.

Contaminants
The tray is a homogeneous black color. The ability of the machine vision system to inspect for contaminants in the seal area will be improved when the defect has high-contrast with respect to the black plastic tray or if the lighting effect on the defect (e.g. light reflection off a liquid droplet) results in high-contrast.

High-contrast contaminants of 0.1” x 0.1” in size can be detected. Contaminants with a grey level greater than or equal to 128 are considered “light” contaminants (0 = black, 255 = white). Based on this information the machine vision system can be expected to detect contaminants with an area of:

0.1” x 0.1” sized contaminant = .01sq. in. area = 6.5 sq. mm area

Low-contrast contaminants will be more difficult to reliably detect. In those cases where the contaminants have a grey level between 20 and 128 they will be considered to be “low-contrast” (0 = black, 255 = white). The system will be able to reliably detect low-contrast contaminants of 0.25” x
grey level below 20 cannot be detected reliably as they are very close to black.

Lighting Design

Either Configuration A or Configuration B will be implemented for the project. The final decision regarding the lighting strategy will be made during the design phase of the project.

Lighting Configuration A - The performance of the machine vision system noted above has been achieved with the use of four high-frequency linear fluorescent lights. One each of the four lights is positioned parallel to one seal edge to create the desired lighting effects. This intense lighting design together with a high camera shutter speed is able to effectively stop the motion of the tray at speeds up to 20in/sec.

Lighting Configuration B - Further testing is required to confirm if the existing strobe lighting with a fiber ring light attachment will create the necessary lighting conditions. This lighting design together with a high camera shutter speed will also be able to stop the motion of the tray.

Input/Output Communication

The vision system will require an inspect trigger for initiating the inspection. The system will output a pass/fail signal and an inspection complete signal to the PLC on the packaging line.

Inputs:

Inspect Trigger – The vision system performs an inspection when the signal transitions from low to high.

Outputs:

Pass/Fail – set high for good trays, set low for trays with one or more seal contaminants.

Inspect Complete – transitions from low to high after each inspection

Assumptions

1. The conveyor must move slower than 20 inches per second (100 feet/min).

2. A white background is needed around the perimeter of the tray. It may be necessary to paint the conveyor guides white or place a white shield on either side of the inspection position. (Rutgers will be responsible to complete these modifications. Xyntek will provide design assistance.)

3. Rutgers will provide a trigger signal from a through-beam sensor positioned on the line at the point of inspection. (Rutgers will be responsible to install the appropriate equipment on the line to provide the needed trigger *(+12 VDC, low-to-high transition)*. Xyntek will provide design assistance.)

4. The vision system will provide a pass/fail signal. Rutgers will perform any PLC program modifications necessary for alarming and/or reject station control.

5. It will be necessary to insure that the existing "portable" machine vision housing be mechanically attached to the line in a fixed position. (It will be the responsibility of Rutgers to meet this requirement. Xyntek will provide the design information regarding the appropriate position of the lighting and camera setup relative to the production line.)

6. Rutgers will be responsible for any mechanical and electrical modifications to the line and the existing vision fixture, as well as the PLC programming.

Primary Project Tasks and Time Estimates

1. Engineering project prep and site visit	2 days - Completed
2. Scope-of-Work review and technical recommendation	3 days - Completed
3. Hardware setup per application development	1 days
4. Final Lighting and Optics design	3 days
5. Vision application development	5 days
6. Vision system testing at Xyntek	3 days
7. I/O configuration and line integration design	2 days
8. Machine Vision control systems programming	2 days
9. Prepare and arrange system for shipping	1 day
10. On-site installation and testing	3 days
11. Client review meetings	2 days
Total Remaining	**22 days**

Xyntek Company Experience

GENERAL :

Xyntek is ideally suited to provide engineering services to augment your existing internal resources. We have an established track record of working with the top Fortune 100 companies. Xyntek's engineering team has extensive experience in the design, implementation, and **validation** of numerous automated manufacturing lines. The engineers who will work on your project not only understand how to integrate automation components, including **MES, MRPII, SCADA, Real Time Continuous or Batch Process Control, Machine Vision, PLC, and Motion Control**, but also the experience and knowledge to design and implement a **real-time control system infrastructure** that is designed for durability, efficiency and cost-effective operational integrity.

Xyntek's mission is to form technological partnerships with world-class manufacturing organizations to provide total line automation, customized per the customer's application requirements. We would be glad to add your organization to our growing list of satisfied customers just to mention a few: **Ortho-McNeil Pharmaceuticals, Johnson & Johnson Consumer Franchises, McNeil Consumer, Ethicon, Lifescan, Ortho Biotech, Novartis, Warner Lambert, Merck & Company, Bristol-Myers Squibb, Pfizer, Hoffmann-La Roche, Rohm & Haas, Genentech, Carter Wallace, Boston Scientific, American Cyanamid Agricultural Research, The West Company, W. L. Gore, DuPont, Allied Signal, Morton International, Occidental Chemicals, Lucent Technologies, Delphi Packard Electric Systems, Ford Motor Company, Canon, and Nestle, etc.**

Business Partners

- POMS
- Cognex
- Wonderware
- Moore Products
- Rockwell Automation

Published Articles

- AB Journal 6/97 (BCX-2000)
- Design News 12/96 (Vision)
- Control Engineering 6/98 (System Integration)
- Converting 4/98 (MVX-OCV & MVX-PQI)
- Food & Drug Packaging 7/99 (MVX-OCV)
- Food & Drug Packaging 3/98 (MVX-Blister)
- Food & Drug Packaging 7/97 (BCX-2000)
- IAN Products 2/97 (BCX-2000)
- ICS 1/98 (MVX-PQI)
- Philadelphia Business Journal (Top 100 fastest growing companies in PA)
- Pharmaceutical & Cosmetic Quality 3/98 (MVX-PQI)
- Pharmaceutical & Cosmetic Quality 12/97 (MVX-OCV)
- Pharmaceutical & Cosmetic Quality 7/97 (Vision)
- Pharmaceutical & Medical Pkg. News 9/99 (Vision)
- Pharmaceutical & Medical Pkg. News 8/99 (Corporate Overview)
- Pharmaceutical & Medical Pkg. News 7/98 (Vision)

- Pharmaceutical & Medical Pkg. News 7/97 (Vision)
- Pharmaceutical & Medical Pkg News 7/96 (Vision)
- Software Connection 3/97 (BCX-2000)
- Software Strategies 5/97 (BCX- 2000)
- Software Strategies 4/97 (Vision)

What our customers have to say...

"Xyntek's capabilities and responsiveness to rapidly changing conditions have allowed us to meet our growing production interface and software needs in a cost effective and timely manner, and to assure our competitiveness and success in the next century."

- **Occidental Chemical Corporation**

"Xyntek has definitely demonstrated their commitment to our project, and truly displays the ability to support the needs of the Pharmaceutical Industry."

- **Ortho-McNeil Pharmaceutical**

"The success of the project is attributable to many factors, not the least of which are your team's technical expertise, professionalism, and work ethic. The fact that the system meets all of the design specifications (without detailed prototyping and extensive front-end design work) demonstrates that your team obviously has the technical machine vision expertise and project management capabilities to successfully execute this type of machine vision project."

"Additionally, we sincerely appreciate your team's professionalism and dedication to the success of the project. Demonstration of this has been evident throughout the project, especially during the installation and commissioning phase. You exceeded our high expectations in this area."

- **DuPont**

"I think it is appropriate that I express our appreciation for the highly professional service we received. The level of expertise in configuring our vision system was outstanding, but not unexpected."

- **McNeil Consumer Products Company**

"It has been a pleasure working with people so dedicated & talented. They worked with me from the beginning to the end as a real team. This made a big difference in the success of the project."

- **The R.W. Johnson Pharmaceutical Research Institute**

Budget Estimate

Item	Description	Budget
1	Machine Vision System Modifications for Tray Inspection	$25,000

- **Includes three days maximum for on-site installation**
- Through-beam sensor, for trigger signal

Item	Description	Budget
2	Time and Material Engineering Rate	$ 1100 per day

Assumptions:

We assume that you will make all necessary arrangements with the plant to ensure that the Xyntek engineer(s) will have access to the production equipment and plant personnel in order to complete their work in a timely manner. Rutgers will be responsible for any mechanical and electrical modifications to the line and the existing vision fixture, as well as the PLC programming.

Terms : Contract will be performed according to the following Terms, as well as, the attached Standard Terms & Conditions.

50% Net Due :	**Purchase Order**
40% Net Due:	**System Acceptance @ Xyntek**
10% Net Due:	**System Installation @ Rutgers**

Shipping : ***Shipping charges have not been included. Charges will be prepaid by Xyntek and added to the invoice at cost plus 15%, as incurred. Customer shipper account number can also be provided instead.***

Expenses : Travel and living expenses have not been included. Actual expenses will be billed at cost as incurred.

Acceptance : The attached System Acceptance Agreement is to be signed at project completion prior to final release of software and documentation.

Purchase Order : ______________ Approved by : ________________________

P.O. Number or Verbal Authorized Representative

Standard Terms & Conditions

- **Validity :** This quote is valid for 30 days.
- **Document Confidentiality :** The attached proposal is the property of Xyntek, Inc. It may not be reproduced or distributed without prior written permission from Xyntek, Inc.
- **Document Reference :** All reference to the proposal must be accompanied by the Quotation Number.
- **Payment :** Terms of payment shall be NET ten (10) days from date of invoice in accordance with the payment schedule.
- **Late Charge :** Xyntek reserves the right to bill for a late charge equal to 1.5% per month of the unpaid balance past due under any invoice, or at the maximum rate legally permitted if less than such amount.
- **Freight Terms :** All equipment and materials will be shipped prepaid by Xyntek and added to the invoice. All sales are made F.O.B. shipping point, with title and risk of loss passing to Buyer at shipping point.
- **Taxes :** All Government charges upon the production, shipment, and sale of goods covered by this agreement, including, but not limited to use, occupation, export, and import taxes shall be paid by the Buyer.
- **Buyer's Solvency :** A purchase order shall constitute a representation that Buyer is solvent, and Xyntek is relying upon such representation. If Xyntek at any time reasonably believes that Buyer is insolvent that Buyer's credit is impaired, Buyer shall be in material breach hereof and Xyntek may, without liability to Buyer, withhold performance hereunder, change the payment terms and/or repossess goods therefore delivered.
- **Cancellation :** If the purchase order is canceled during the project by the customer, the customer will owe payment of all engineering services performed by Xyntek, Inc. and all expenses incurred by Xyntek, up to the point of cancellation and an additional Cancellation Fee of 25% of the contract price.
- **Acceptance :** Any buyer changes made after Xyntek's acceptance of an order that affect the specifications or configurations of the goods or otherwise affect the scope of the order, shall be submitted in writing by the Buyer and shall become binding only if approved by Xyntek in writing. Resultant delivery delays and/or additional expenses to Xyntek shall be so noted on the order and supported by a written change to the order. The attached System Acceptance Agreement is to be signed by an authorized company representative prior to final release of final documentation and software diskettes.
- **Rejection :** If Buyer wrongfully rejects or revokes acceptance of any products or services supplied by Xyntek, or fails to make any payment when due, Xyntek may recover as damages the purchase price, or in case of cancellation prior to delivery, the amount stated herein, and any costs of collection, including reasonable attorney's fees.
- **Security Interest :** Xyntek reserves a security interest in all systems, equipment and related products set forth in the order and in proceeds thereof to secure payment of the purchase price. In the event that Buyer shall default in the payment of the purchase price or any other obligation under these terms and conditions, all such obligations shall be forthwith due and payable without demand, notice of nonpayment, protest, or further actions of any kind, and Xyntek may exercise any and all rights afforded to Xyntek by the laws of the applicable jurisdiction as Xyntek shall deem appropriate. A copy of the order may be filed at any time as a financing statement necessary to so perfect Xyntek's security interest.
- **Delays :** In the event that Buyer delays the scheduled shipment or completion of engineering services, Buyer will be responsible to reimburse Xyntek for all costs which it incurs as a result of the delay including, but not limited to material and labor price increases, travel and living expenses, as well as, production and labor rescheduling inefficiencies.
- **Software :** All software and source code developed by Xyntek remains the intellectual property of Xyntek and is not a project deliverable, unless otherwise agreed upon in writing. All software provided by Xyntek is licensed to be installed and used on only one machine. It may not be reproduced or copied for use in other applications or with other machines.
- **Delivery :** Xyntek will make every effort to deliver the proposed system and services on time. However; if a vendor delays manufacturing and delivery of equipment to Xyntek, or delivers non working hardware or software to Xyntek, or if necessary information such as specifications are delayed getting to Xyntek from the customer, Xyntek will not be in breach of its contract, and will not be held liable nor will be penalized for such delays beyond its control.
- **Limitation of Liability :** Xyntek shall not be liable for damages caused by delay in performance. In no case, regardless of the form or the cause of action, shall Xyntek's liability exceed the price to Buyer of the contract. Buyer agrees that in no event shall Xyntek's liability extend to include incidental or consequential damages. Consequential damages shall include but not be limited to loss of anticipated profits, loss of use, loss of revenue, cost of capital and damage or loss of other property or equipment. In no event shall Xyntek be liable for property damage and/or third party claims covered by umbrella insurance and/or indemnity coverage provided to Buyer, its assigns, and each successor in interest to the goods and/or services provided hereunder. This quotation has been prepared based on discussions and information received from the customer. Xyntek, Inc. will not be held accountable for items not given or made known to Xyntek at the time of submittal of this quotation.
- **Force Majeure :** Xyntek will not be liable for any failure to perform under the order and these terms and conditions if inability to obtain parts or supplies at reasonable prices or through usual and regular sources on a timely, interruption of transportation, government regulation, labor disputes, strikes, riots, insurrection, war, civil commotion, fire, flood, accident, storm, or act of God, or other cause beyond Xyntek's control makes it impractical for Xyntek to perform.
- **Hiring :** If any of Xyntek's engineers or team members are hired by your corporation within three years from the date of the completion of Xyntek's contract, a fee equal to three times their annual salary will be due Xyntek, Inc. unless negotiated otherwise with Xyntek, Inc. and prior written permission is received from Xyntek, Inc.
- **Defaming:** The customer's management will guarantee that under no circumstance will its management or its employees defame Xyntek, or any of its employees or management.
- **Counter Offers :** If any counter offers are to be made to this quotation or its terms and conditions, they must be made in writing and approved in writing by Xyntek to be binding.

SYSTEM ACCEPTANCE AGREEMENT

By signing this System Acceptance Agreement,

(Customer)

agrees that Xyntek, Inc. has fulfilled all of their obligations regarding the contract under

Purchase Order ________________, dated ________________ for the

(P.O. Number) (P.O. Date)

____________________________________ project in ______________________ .

(Project Name) (Location)

_________________________ agrees that Xyntek, Inc. has met all the requirements

(Customer)

and provided all materials and performed all engineering development work and support as specified in the contract. Any work hereafter, will be performed at Time and Material rates.

____

Date

____________________________ _________________________

Customer Representative Xyntek Representative